National Park Service
U.S. Department of the Interior

Water Resources Division
Natural Resource Program Center

Technical Report NPS/NRWRD/NRTR-2005/336

SAINT-GAUDENS NATIONAL HISTORIC SITE

NEW HAMPSHIRE

WATER RESOURCES INFORMATION AND ISSUES OVERVIEW REPORT

The National Park Service Water Resources Division is responsible for providing water resources management policy and guidelines, planning, technical assistance, training, and operational support to units of the National Parks System. Program areas include water rights, water resources planning, regulatory guidance and review, hydrology, water quality, watershed management, watershed studies, and aquatic ecology.

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Front cover photos by Alan C. Ellsworth

Saint-Gaudens National Historic Site

New Hampshire

Water Resources Information and

Issues Overview Report

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WATER RESOURCES DIVISION

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EXECUTIVE SUMMARY

Saint-Gaudens National Historic Site (SAGA) was established by Congress in 1964 (Public Law 88-543) to preserve, interpret, and exhibit historically significant properties associated with the life and cultural achievements of Augustus Saint-Gaudens. The Saint-Gaudens National Historic Site comprises a 150 ac (60 ha) upland to wetland transitional area located in Cornish, New Hampshire. The serene environment, supported by brooks and ponds flowing through SAGA to the Connecticut River and views of Mount Ascutney, provided an inspiring setting for the artistic community established at this site. The SAGA landscape includes manicured gardens, forested hillsides, riparian, open water, and marsh communities. The Park's water resources are invaluable as both natural and cultural resource components.

The National Park Service seeks to protect park water resources through sound watershed management practices. Hydrologic systems are managed to support healthy ecosystems, maintain applicable legal standards, and meet the needs established through a park's enabling legislation. Pond maintenance and water quality monitoring assessment were identified as predominant hydrologic needs at the SAGA. Additional concerns include wetlands preservation, adjacent land use, and the park's domestic water infrastructure.

The Water Resources Scoping Report identifies the hydrologic environment, describes significant water issues, and provides guidance for hydrologic monitoring, research, and management. The hydrologic environment includes climate, hydrogeology, surface water features, water chemistry, flora and fauna, existing aquatic habitat, land use, and infrastructure. Significant water issues were identified through consultation with park staff and review of available literature. Guidance herein provides NPS staff with a description of the Saint-Gaudens National Historic Site's hydrologic resources, and recommendations for addressing management concerns.

INTRODUCTION

Purpose

Water is a significant resource in units of the National Park Service, which is integral in supporting natural systems and human needs. Consistent with its fundamental purpose, the National Park Service seeks to protect surface and ground waters as integral components of a unit's cultural landscape as well as its aquatic and terrestrial ecosystem by carefully managing the consumptive use of water. The National Park Service also strives to maintain the natural quality of surface and ground waters in accordance with all applicable federal, state, and local laws and regulations.

Water is an important component of both the cultural and natural landscapes at Saint-Gaudens National Historic Site. The purpose of this Water Resources Information and Issues Overview Report is to provide park managers with background to the water resources at SAGA, to identify and discuss water-related management issues, and to provide park management with considerations for future actions to address these issues.

Historic Overview

Augustus Saint-Gaudens' arrival in Cornish, New Hampshire in 1885 marked the beginning of the Cornish Art Colony (1885-1930). More than 70 artists, architects, playwrights, and other art patrons lived in Cornish and neighboring Plainfield, New Hampshire, during the "Guilded Age" of the late 19th and early 20th centuries. In addition to Saint-Gaudens, other resident artists included Thomas Dewing, George de Forest Brush, Maxfield Parrish, and Kenyon Cox. Several of Saint-Gaudens' relatives were also artists in Cornish: his brother, Louis Saint-Gaudens, and Louis' wife, Annetta Johnson Saint-Gaudens, were fellow sculptors; daughter-in-law, Carlota Dolley Saint-Gaudens, was a painter and miniaturist. The artists of the "Cornish Colony" were stimulated by each other's creativity and intelligence, and relished the area's natural beauty, climate, and seclusion. They promoted the arts through various events and supported local libraries and summer art schools.

During the "Gilded Age" (1865-1900) industry boomed and fortunes were made. Great public monuments and buildings were constructed and homes were decorated in lavish fashion. Saint-Gaudens was commissioned by the social elite, and he is credited with helping shape the American perception of sculpture as an art form. He created more than 200 works of art during a career that spanned three decades, with commissions that ranged from large public statues to bas-reliefs for prominent private clients. He also designed the U.S. ten and twenty-dollar gold coins in 1907.

Following the death of Augustus Saint-Gaudens in 1907, the sculptor's widow, Augusta, sought to preserve the house, studios, and gardens as a memorial to the artist's life and works. From 1907 until her death in 1926, Augusta maintained virtually everything at the site as it was prior to her husband's death, with the exception of a couple of building additions. Augusta welcomed visitors and encouraged them to frequent the studios and view where “the Saint” had worked.

Upon Augusta’s death, the site was turned over to the Trustees of the Saint-Gaudens Memorial, who operated the site as a museum, offering expanded visitor programs and acquiring additional acreage to protect the land and views surrounding the artist’s historic property. The Trustees donated the site to the National Park Service in 1964, the year that Congress passed the legislation establishing Saint-Gaudens National Historic Site. The Trustees have continued to support the park in many ways, including sponsoring art exhibitions and concerts and providing funds for the conservation and acquisition of art works.

The landscape at the Saint-Gaudens National Historic Site (SAGA) is preserved by the National Park Service to allow visitors to experience the setting that inspired the artist community in the early twentieth century. Two streams, an historic swimming hole, a mill pond and accompanying wetland area are accessible by an interpretive trail system. Views of the Connecticut River Valley and Mount Ascutney are also provided. Protection of the aquatic resources, and vistas allowing their appreciation, are essential for providing a visitor experience that preserves the essence of Saint-Gaudens’ motivations.

Park Location and Enabling Legislation

The Saint-Gaudens National Historic Site is located at 43º 30’ N latitude and 72º 22’ W longitude in the Town of Cornish, Sullivan County, New Hampshire. Route 12A, which parallels the Connecticut River, runs along the western boundary of SAGA (Figure 1). Saint-Gaudens Road provides the visitor access from Route 12A. Total land area currently managed by SAGA encompasses 150 ac (60 ha).

Saint-Gaudens National Historic Site was established 31 August 1964 by an act of Congress (*Public Law 88-543*). The enabling legislation established SAGA in order to preserve historically significant properties associated with the life and cultural achievements of Augustus Saint-Gaudens. The Congressionally authorized boundary area, which was originally limited to 150 ac (60 ha), was expanded to 370 (148 ha) by the 106^{th} Congress on 27 June 2000 (U.S. Senate, 2000; NPS, 1996).

The Macleay property (58.25 ac [23.3 ha]), located between the Connecticut River and Route 12A, is within the authorized boundary (Figure 2). The parcel is currently owned by the Saint-Gaudens Memorial, Inc., with the prior owner (Macleay) possessing a life tenancy agreement. Property management will continue in consultation with SAGA staff to insure adherence to the SAGA mission. The Blow-Me-Down Pond/Brown (37.5 ac [15 ha]) and Dingleton Hill/Bulkeley (120.5 ac [48.2 ha]) land holdings are additional adjacent lands of interest to SAGA for protection, which will likely occur through easements (Dunn, pers. comm.; NPS, 1996).

Figure 1. Location of Saint-Gaudens National Historic Site in the Northeastern United States (*).

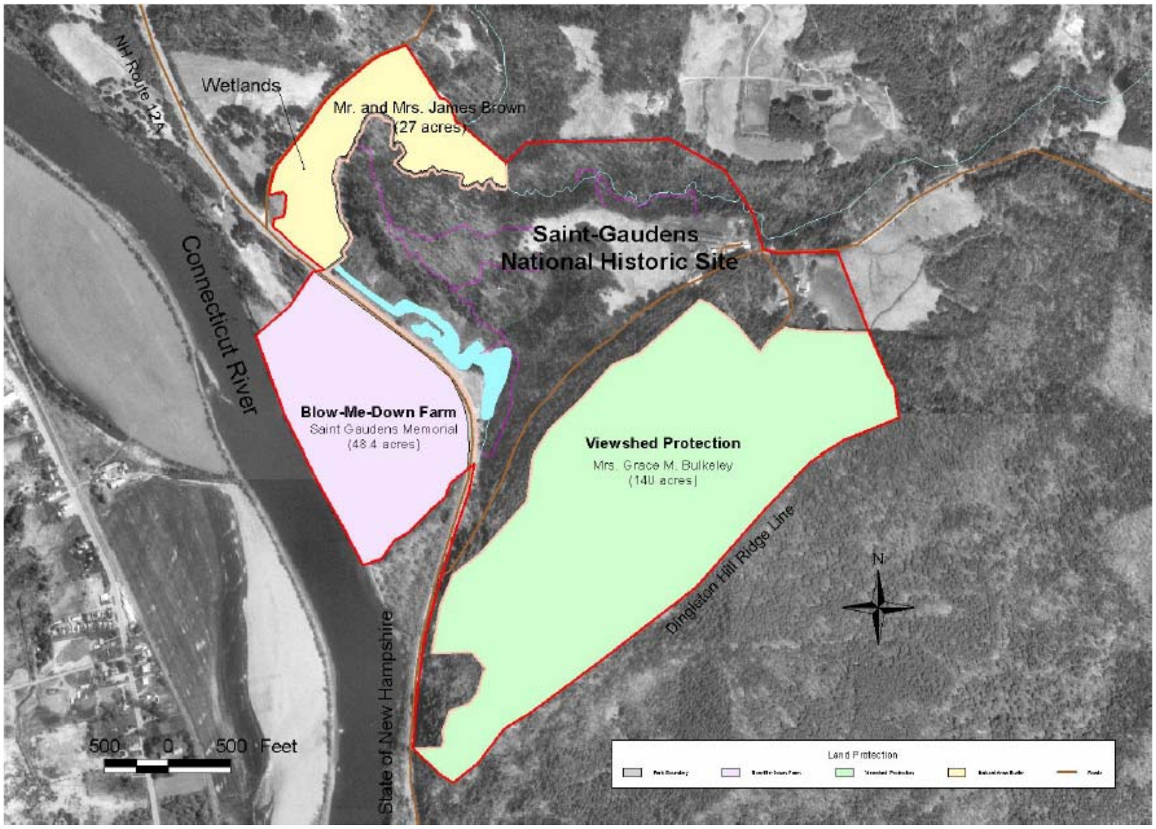


Figure 2. Saint-Gaudens National Historic Site land use protection and property boundaries. (Walasewicz)

Natural Resource Management Legislation

National Park Service Organic Act (1916)

Through this act, Congress established the National Park Service and mandated that it "shall promote and regulate the use of the federal areas known as national parks, monuments, and
reservations by such means and measures as conform to the fundamental purpose of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of future generations." Congress, recognizing that the enjoyment by future generations of the national parks can be ensured only if the superb quality of park resources and values is left unimpaired, has provided that when there is a conflict between conserving resources and values and providing for enjoyment of them, conservation is to be predominant.

The (*General Authorities Act of 1970*) reinforced this act -- all parklands are united by a common preservation purpose, regardless of title or designation. Hence, federal law protects all water resources in the national park system equally, and it is the fundamental duty of the National Park Service to protect those resources unless otherwise indicated by Congress.

National Environmental Policy Act (1969)

Congress passed the National Environmental Policy Act (NEPA) in 1969. Environmental compliance in the National Park Service encompasses the mandates of NEPA and all other federal environmental laws that require evaluation, documentation and disclosure, and public involvement, including the Endangered Species Act, Clean Water Act, Executive Orders on Floodplains and Wetlands, and others.

All natural resource management and scientific activities are subject to environmental analysis under NEPA through the development of environmental assessments and environmental impact statements. Parks are encouraged to participate as cooperating agencies in the environmental compliance process to the fullest extent possible when National Park Service resources may be affected, and as set forth in Council on Environmental Quality (CEQ) regulations. Participation by the National Park Service in the environmental compliance processes of other agencies and jurisdictions is an important management tool. It can provide the National Park Service with information that will allow the Service to respond to possible external threats to a park well before they occur.

Section 102 of NEPA sets forth a procedural means for compliance. The CEQ regulations further define the requirements for compliance with NEPA. Park decisions that may have an impact to the human environment are subject to the NEPA process. Procedural guidelines are available in *Director's Order #12*.

Clean Air Act (1970), as amended

The Clean Air Act regulates airborne emissions of a variety of pollutants from area, stationary, and mobile sources. The 1990 amendments to this act were intended primarily to fill the gaps in the earlier regulations, such as acid rain, ground level ozone, stratospheric ozone depletion and air toxics. The amendments identify a list of 189 hazardous air pollutants. The U.S. Environmental Protection Agency must study these chemicals, identify their sources, determine if emissions standards are warranted, and promulgate appropriate regulations.

Federal Water Pollution Control Act (1972)

The Federal Water Pollution Control Act, more commonly known as the Clean Water Act, was first promulgated in 1972 and amended several times since (1977, 1987 and 1990). This law is designed to restore and maintain the chemical, physical and biological integrity of the nation's waters, including the waters of the national park system. To achieve this, the act called for a major grant program to assist in the construction of municipal sewage treatment facilities, and a program of effluent limitations designed to limit the amount of pollutants that could be discharged. Effluent limitations are the basis for permits issued for all point source discharges, known as the National Pollutant Discharge Elimination System (NPDES).

As part of the act, Congress recognized the primary role of the states in managing and regulating the nation's water quality. *Section 313* requires that all federal agencies comply with the requirements of state law for water quality management, regardless of other jurisdictional status or landownership. States implement the protection of water quality under the authority granted by the Clean Water Act through best management practices and through water quality standards. Standards are based on the designated uses of a water body or segment of water, the water quality criteria necessary to protect that use or uses, and an anti-degradation provision to protect the existing water quality.

A state's antidegradation policy is a three-tiered approach to maintaining and protecting various levels of water quality. Minimally, the existing uses of a water segment and the quality level necessary to protect the uses must be maintained. The second level provides protection of existing water quality in segments where quality exceeds the fishable/swimmable goals of the Clean Water Act. The third level provides protection of the state's highest quality waters where ordinary use classifications may not suffice; these are classified as Outstanding National Resources Waters (ONRW).

Section 303 of the act requires the promulgation of water quality standards by the states. Additionally, each state is required to review its water quality standards at least once every three years. This section also requires the listing of those waters where effluent limitations are not stringent enough to implement any water quality standard [so called 303(d) list]. Each state must establish, for each of the waters listed, total maximum daily loads for applicable pollutants.

Section 401 requires that any applicant for a federal license or permit to conduct an activity which will result in a discharge into waters of the U.S., shall provide the federal agency, from which a permit is sought, a certificate from the state water pollution control agency stating that any such discharge will comply with applicable water quality standards.

Section 404 of the Clean Water Act further requires that a permit be issued for discharge of dredged or fill materials in waters of the U.S., including wetlands. The U.S. Army Corps of Engineers administers the Section 404 permit program with oversight and veto powers held by the U.S. Environmental Protection Agency. The New England Division of the U.S. Army Corps of Engineers offers a general permit (GP-52), which eliminates separate Corps approval for minor, non-controversial projects involving wetlands less than 3 acres (1.2 ha) in New Hampshire (State of New Hampshire Wetland Rules Part WT 100-700).

It was the 1987 amendment to the Clean Water Act that finally established a stringent nonpoint source control mandate. Subsequent amendments further developed this mandate by requiring that states develop regulatory controls over nonpoint sources of pollution and over stormwater runoff from industrial, municipal, and construction activities. Many of the National Park Service's construction activities are regulated by the Clean Water Act under the stormwater permitting requirements.

Endangered Species Act (1973)

The Endangered Species Act requires the National Park Service to identify and promote the conservation of all federally listed endangered, threatened, or candidate species within any park unit boundary. This act requires all entities using federal funding to consult with the Secretary of Interior on activities that potentially impact endangered flora and fauna. It requires agencies to protect endangered and threatened species as well as designated critical habitats. While not required by legislation, it is the policy of the National Park Service to also identify state and locally listed species of concern and support the preservation and restoration of those species and their habitats.

Redwood National Park Act (1978)

In 1978 an act expanding Redwood National Park further amended the general authorities of the National Park Service to mandate that all park system units be managed and protected "in light of the high public value and integrity of the national park system." Furthermore, no activities should be undertaken "in derogation of the values and purposes for which these various areas have been established", except where specifically authorized by law or as may have been or shall be directly and specifically provided for by Congress. Thus, by amending the general Authorities Act of 1970, this act reasserted system-wide the high standard of protection prescribed by Congress in the Organic Act.

National Parks Omnibus Management Act (1998)

Recognizing the ever increasing societal pressures being placed upon America's unique natural and cultural resources contained in the national park system, this act attempts to improve the ability of the National Park Service to provide state-of-the-art management, protection, and interpretation of and research on the resources of the national park system by:

- assuring that management of units of the national park system is enhanced by the availability and utilization of a broad program of the highest quality science and information;
- authorizing the establishment of cooperative agreements with colleges and universities and the establishment of cooperative study units to conduct multi-disciplinary research and develop integrated information products on the resources of the national park system;
- undertaking a program of inventory and monitoring of national park system resources to establish baseline information and to provide information on the long-term trends in the condition of national park system resources; and
- taking such measures as are necessary to assure the full and proper utilization of the results of scientific study for park management decisions. In each case in which an

action undertaken by the National Park Service may cause a significant adverse effect on a park resource, the administrative record shall reflect the manner in which unit resource studies have been considered. The trend in the condition of resources of the national park system shall be a significant factor in the annual performance.

Section 10 of the Rivers and Harbors Appropriations Act of 1899, as amended

This was the first general legislation giving the U.S. Army Corps of Engineers jurisdiction and authority over the protection of navigable waters. Navigable waters of the U.S. are those waters that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. U.S. Army Corps of Engineers permits are required under section 10 for structures and/or work in or affecting navigable waters of the U.S.

The U.S. Army Corps of Engineers began regulation of wetlands under this act, and then received a much broader grant of jurisdictional authority under the Clean Water Act. Because of the broader geographic reach of "waters of the U.S." jurisdiction under the Clean Water Act, the Rivers and Harbors Act jurisdiction will usually not be of significance to wetlands regulation in current cases. There are, however, several situations in which Rivers and Harbors Act jurisdiction alone will be available: when an exemption from section 404 coverage applies, and when activities, as opposed to waters, are covered by the Rivers and Harbors Act and not the Clean Water Act.

Fish and Wildlife Coordination Act of 1965

This act requires federal agencies to consult with the U.S. Fish and Wildlife Service or the National Marine Fisheries Service and with parallel state agencies whenever water resource development plans result in alteration of a body of water. The Secretary of the Interior is authorized to assist and cooperate with federal agencies to "provide that wildlife conservation shall receive equal consideration and be coordinated with other features of water-resource development programs."

Executive Order 11988 for floodplain management

The objective of E.O. 11988 (Floodplain Management) is "… to avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative." For non-repetitive actions, the E.O. states that all proposed facilities must be located outside the limits of the 100-year floodplain. If there were no practicable alternative to construction within the floodplain, adverse impacts would be minimized during the design of the project. National Park Service guidance pertaining to this E.O. can be found in *Director's Order #77-2*, Floodplain Management (2003).

It is National Park Service policy to recognize and manage for the preservation of floodplain values, minimize potentially hazardous conditions associated with flooding, and adhere to all federally mandated laws and regulations related to the management of activities in flood-prone areas. Particularly, it is the policy of the National Park Service to:

- restore and preserve natural floodplain values;
- avoid to the extent possible, the long- and short-term environmental impacts associated with the occupancy and modification of floodplains, and avoid direct and indirect support of floodplain development wherever there is a practicable alternative;
- minimize risk to life and property by design or modification of actions in floodplains, utilizing non-structural methods when possible, where it is not otherwise practical to place structures and human activities outside of the floodplain; and,
- require structures and facilities located in a floodplain to have a design consistent with the intent of the Standards and Criteria of the National Flood Insurance Program (44 CFR 60).

Executive Order 11990 Protection of Wetlands

Executive Order 11990, entitled "Protection of Wetlands", requires all federal agencies to "minimize the destruction, loss or degradation of wetlands, and preserve and enhance the natural and beneficial values of wetlands." Unless no practical alternatives exist, federal agencies must avoid activities in wetlands that have the potential for adversely affecting the integrity of the ecosystem. National Park Service guidance for compliance with E.O. 11990 can be found in *Director's Order #77-1* and Procedural Manual #77-1, "Wetlands Protection."

Particularly, it is the policy of the National Park Service to:

- avoid to the extent possible the long- and short-term adverse impacts associated with the destruction or modification of wetlands;
- preserve and enhance the natural and beneficial values of wetlands;
- avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative;
- adopt a goal of no net loss of wetlands and strive to achieve a longer-term goal of net gain of wetlands servicewide;
- conduct or obtain parkwide wetland inventories to help assure proper planning with respect to management and protection of wetland resources;
- use "Classification of Wetlands and Deepwater Habitats of the United States " (Cowardin, *et al*., 1979) as the standard for defining, classifying and inventorying wetlands;
- employ a sequence of first avoiding adverse wetland impacts to the extent practicable; second, minimizing impacts that could not be avoided; and lastly, compensating for remaining unavoidable adverse wetland impacts at a minimum 1:1 ratio via restoration of degraded wetlands;
- prepare a Statement of Findings to document compliance with Director's Order #77-1 when the preferred alternative addressed in an environmental assessment or environmental impact statement will result in adverse impacts on wetlands; and,

- restore natural wetland characteristics or functions that have been degraded or lost due to previous or ongoing human activities, to the extent appropriate and practicable.

Executive Order 13112 for invasive species

Signed in 1999, this E.O. complements and builds upon existing federal authority to aid in the prevention and control of invasive species.

National Park Service Management Policies and Guidelines (2001)

The National Park Service Management Policies (2001) provide broad policy guidance for the management of units of the national park system. Topics include park planning, land protection, natural and cultural resource management, wilderness preservation and management, interpretation and education, special uses of the parks, park facilities design, and concessions management.

With respect to water resources, it is the policy of the National Park Service to determine the quality of park surface and ground water resources and avoid, whenever possible, the pollution of park waters by human activities occurring within and outside of parks. In particular the National Park Service will work with appropriate governmental bodies to obtain the highest possible standards available under the Clean Water Act for protection of park waters; take all necessary actions to maintain or restore the quality of surface and ground waters within the parks consistent with the Clean Water Act and all applicable laws and regulations; and, enter into agreements with other agencies and governing bodies, as appropriate, to secure their cooperation in maintaining or restoring the quality of park water resources.

The National Park Service will also manage watersheds as complete hydrologic systems, and will minimize human disturbance to the natural upland processes that deliver water, sediment and woody debris to streams. The National Park Service will manage streams to protect stream processes that create habitat features such as floodplains, riparian systems, woody debris accumulations, terraces, gravel bars, riffles and pools.

The National Park Service will achieve the protection of watershed and stream features primarily by avoiding impacts to watershed and riparian vegetation and by allowing natural fluvial processes to proceed unimpeded. When conflicts between infrastructure (such as bridges) and stream processes are unavoidable, park managers will first consider relocating or redesigning facilities, rather than manipulating streams. Where stream manipulation is unavoidable, managers will use techniques that are visually non-obtrusive and that protect natural processes to the greatest extent practicable.

Additionally, natural shoreline processes (such as erosion, deposition, dune formation, and shoreline migration) will be allowed to continue without interference. Where human activities or structures have altered the nature or rate of natural shoreline processes, the National Park Service will investigate alternatives for mitigating the effects of such activities or structures. The National Park Service will comply with the provisions of

Executive Order 11988 and state coastal zone management plans prepared under the *Coastal Zone Management Act*.

Recommended procedures for implementing service-wide policy are described in the National Park Service guideline series. The guidelines most directly pertaining to actions affecting water resources not listed above include:

Director's Order #83: Public Health;
NPS-75: Natural Resource Inventory and Monitoring; and
NPS-77: Natural Resources Management.

HYDROGRAPHY

Land Use and Demography

The Cornish, New Hampshire Township encompasses 27,195 ac (10,878 ha) of land area and 387.5 ac (155 ha) of inland water area (NHELMIB, 2003). Primary land use described by the Town of Cornish is farm land, residential, unmanaged pine forest, wetland, and limited managed forest areas. Major local crops include corn, potatoes, soy, fruits, and vegetables (Yaro, et al., 1993).

Cornish has maintained a population of 1660 persons, resulting in a population density of 40 persons per square mile over the past decade (NHELMIB, 2003). As of April 2000, 697 housing units were established in Cornish with 466 of those described as family households with an average size of 3.0 persons and a median age of 41.6 (NHELMIB, 2003). Residential sanitation is provided through private septic systems and water supply is derived from private wells.

Surface Water

Saint-Gaudens National Historic Site waters are contained within the Cornish-Plainfield tributaries sub-watershed (USGS Hydrologic Unit Code 01080104, Watershed Code 090) (Plate 1). The SAGA boundaries encompass portions of Blow-Me-Down (BMD) and Blow-Me-Up (BMU) Brooks and BMD Pond. Blow-Me-Up Brook is a second order stream that flows into BMD Brook above BMD Pond. Blow-Me-Down Brook is the primary water source for BMD Pond, which is formed behind a grist mill impoundment along Route 12A (see Figure 3). Blow-Me-Down Brook continues approximately 1300 ft (400 m) from the impoundment to the Connecticut River near river mile 198. Average reported streamflow for Blow-Me-Down Brook, based on limited measurements made below the dam, is 19 $ft^3\ s^{-1}$ (0.54 $m^3\ s^{-1}$) (Walasewicz, 2003). Stream discharge in this climatic zone increases in the spring and fall with measurable low flows occurring in late summer to early autumn (Trench, 2000).

Blow-Me-Down Pond has a storage capacity of 105 ac·ft (130,000 m^3), a 5 ac (2 ha) surface area, and a contributing watershed area of 18,125 ac (7250 ha) (Faris, 2000; Cronan, et al., 1981). An historic swimming pond along BMU Brook and Farm Pond are small impoundments (approximately 3 ac·ft (3700 m^3) storage capacity) also located within the SAGA boundaries (Faris, 2000). The historic swimming hole is located at the end of the BMU interpretive trail below the resident artist's studio. Farm Pond is a spring fed impoundment located in the southeast section of the SAGA property (NE of USDI Boundary Disk # AP 47).

The mean streamflow rate for the Connecticut River measured at the West Lebanon gage (USGS station 01144500), which is the nearest continuous recording gage to the SAGA, is estimated at 7060 $ft^3 s^{-1}$ (200 $m^3 s^{-1}$). The maximum mean streamflow was 10,943 $ft^3 s^{-1}$ (310 $m^3 s^{-1}$) in 1973 and the minimum was 4695 $ft^3 s^{-1}$ (133 $m^3 s^{-1}$) in 1941 for the period of record (1913 – present). The watershed area for this gage, which is located approximately 12.5 mi (20 km) upstream of the SAGA near river mile 212, is 2.65 x 10^6 ac (1.06 x 10^6 ha). The watershed area of the entire Connecticut River basin is 7.3 x 10^6 ac (2.92 x 10^6 ha), with a total river length from the headwaters in Canada to its mouth at the Long Island Sound of 405 mi (650 km) (Wilkinson, 1967). The Connecticut River Watershed Council (www.ctriver.org) and the Connecticut River Joint Commissions, Inc. (www.crjc.org) provide additional information on research publications, management reports, and initiatives in the watershed.

Water Quality

Water quality in the SAGA vicinity, particularly within the Connecticut River system, has been degraded by anthropogenic pollution (NPS, 2000; Zimmerman, *et al*., 1996). Parameters measured in the current within-Park water quality monitoring program include temperature, dissolved oxygen, pH, conductivity, turbidity, NH_4, NO_3, PO_4, fecal coliform, and the Isaac Walton League Stream Quality Survey (SQS) biological index (Walasewicz, 2003). Review of the Park's monitoring data indicates normal seasonal variations with overall good aquatic integrity (Walasewicz, 2003).

Results of 2,831 water quality observations for a total of 196 parameters were reviewed for the area within SAGA boundaries, three miles upstream, and one mile downstream of the Park's boundaries from 1956 to 1998. Environmental Protection Agency drinking, bathing, and aquatic life protection exceedances were identified in the area observed for pH, cadmium, chromium, copper, lead, arsenic, nickel, fecal bacteria, and turbidity during the period examined. Sample locations within the park boundaries indicated one pH exceedance for multiple locations on different occasions, and a single point exceedance for fecal coliform and arsenic at two separate locations (NPS, 2000).

Climate

The National Oceanic and Atmospheric Administration collects climatological data at the Lebanon Municipal Airport, approximately 9 mi (15 km) north of SAGA (43 38' N, 72 19' W, elevation 171 m (561 ft). Data for this site is reported as monthly normals, or 30 month averages. Annual average air temperature is 44.6º F (7º Celsius) with an average maximum of 81.3º F (27.4º Celsius) occurring in July and an average minimum of 7.7º F (-13.5º Celsius) in January (NOAA, 2002). Air masses generally flow from west to east in this region with northwesterlies occurring in the winter and southwest winds in the summer months (Likens and Bormann, 1995). Annual precipitation measured at Lebanon, NH is 35.5 in (900 mm) with a monthly maximum of 3.5 in (90 mm) occurring in August and minimum of 2 in (50 mm) in February (NOAA, 2002). Assuming precipitation falls in its frozen form from November through April, 45% of the total precipitation for this location is received as snow. Annual evapotranspiration for the area is approximately 20 in (500 mm) (Wilkinson, 1967).

Geology

The geologic structure is the northerly trending Bronson Hill anticline, which is composed of slate, phyllite, and quartz-sericite schist known as the Gile Mountain formation (Billings, 1956). Geologic evidence indicates active volcanism during the Jurassic Period was followed by a period of erosion until the glacial activity of the Pleistocene (Cronan, *et al*., 1981). Blow-Me-Up Brook ravine sidewalls within the SAGA are composed of glacial lake outwash, which has eroded to bedrock and consolidated glacial till along the streambed (Cronan, *et al*., 1981). During the Pleistocene period of deglaciation Glacial Lake Hitchcock extended across the Connecticut River Valley from New Britain, Connecticut to Burke, Vermont (Moore, *et al*., 1994). The present SAGA elevation range is from approximately 330 ft (100 m) to 650 ft (198 m) for the in-fee boundary and 780 ft (238 m) for the authorized boundary.

Hydrogeology

The hydrogeology of the SAGA area is dominated by coarse grained, stratified-drift aquifers, which are a result of glacial lake deposits. An aquifer with a saturated thickness of approximately 40 ft (12.2 m) exists along the toe of the SAGA hillslopes approaching BMD Pond. Transmissivity for this aquifer is less than 1000 ft^2 (93 m^2) per day. Wells and bore hole investigations indicated only unconsolidated materials. Groundwater ionic concentrations measured from a SAGA spring were dominated by Ca and HCO_3 + CO_3, resulting in very hard water (220 mg l^{-1} as $CaCO_3$), which can cause incrustations on pipes. Topography, substrate composition, spring and well locations for geochemical analyses have been mapped for this area (Plate 1) (Moore, *et al*., 1994).

Wetlands

Wetlands in the southeastern portion of SAGA and Sites A and B (figure 3) were reviewed by the Environmental Protection Agency using the US Army Corps of Engineers 1987 wetlands delineation methods to support the 1996 General Management Plan (NPS, 1996). Forested wetlands were noted along the south of Saint Gaudens Road (figure 3) and adjacent to the shrub wetlands bordering BMD Pond. The south-easternmost wetland begins at the headwaters of a stream originating from a groundwater seep. The wetland west of the SAGA pump house consists of several intermittent streams and is characterized by pit and mound topography. All wetlands noted were listed as jurisdictional for section 404 of the Clean Water Act (Schweisberg, 1992).

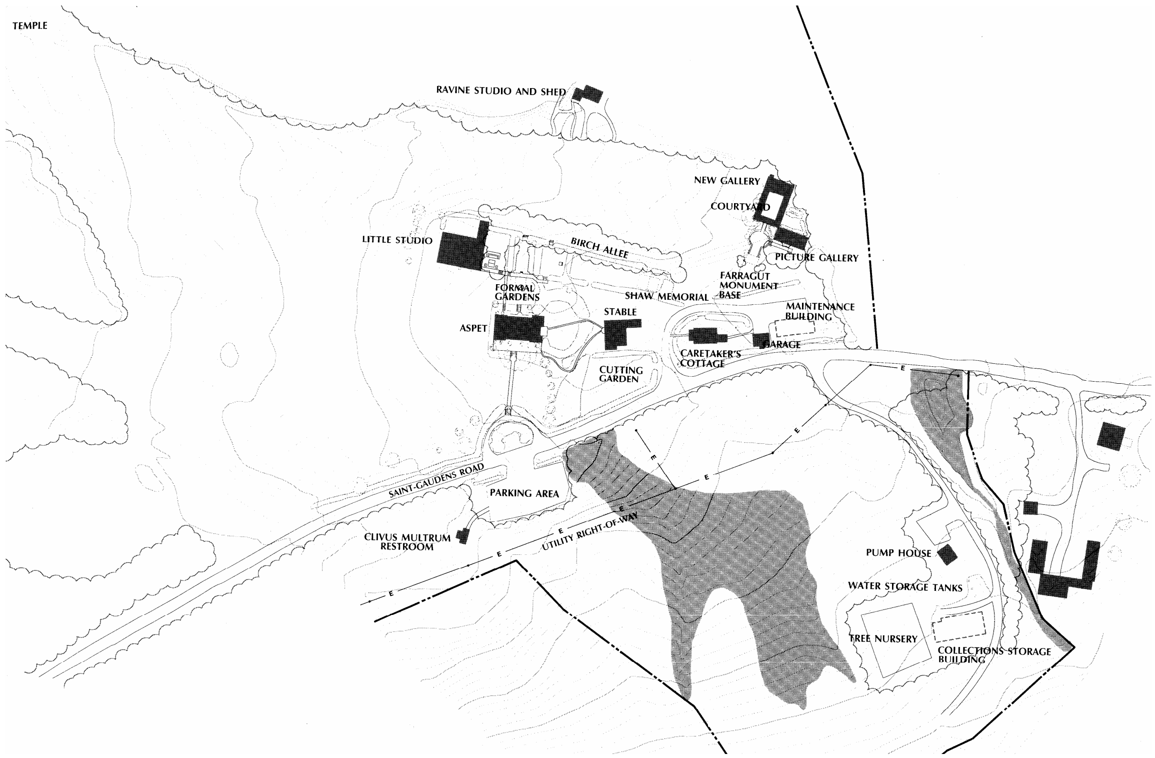


Figure 3. Developed area for SAGA based on 1995 conditions. Shaded areas are wetlands with ephemeral streams. The Visitor's Center is now located in the 'Maintenance Building' shown above. A maintenance facility and storage shed have been constructed at the end of the storage road (from NPS, 1996).

A 1998 inventory, utilizing the US Army Corps of Engineers 1987 wetlands delineation methods, described 18.41 ac (7.5 ha) of wetland within the SAGA boundary (Figure 4). This area is in addition to the wetlands described by Schweisberg (1992). Five Palustrine wetland types were identified in the New England Environmental Associates, Inc. survey: 1) unconsolidated bottom, intermittently exposed; 2) unconsolidated bottom, permanently flooded; 3) emergent, semi-permanently flooded; 4) scrub-shrub, seasonally flooded; and 5) forested, seasonally flooded. Palustrine wetlands include all nontidal wetlands dominated by trees, shrubs, persistent emergent vegetation and emergent mosses or lichens (NEEA, 1998).

Wetland type 1 above identifies BMU Brook, an intermittent stream with a cobble and gravel substrate dominated by *Osmunda cinnamomea* and *Betula lutea* along its banks. Type 2 is BMD Pond. Type 3 is the semi-permanently flooded area surrounding BMD Pond, which is dominated by emergent vegetation including *Typha latifolia*, *Alisma triviale*, and *Carex lacustris*. Type 4 is the transition area from BMD Pond to the upland zone, which may experience water table drawdown of up to 6 inches and is dominated by *Lonicera canadensis* and *Alnus rugosa*. The type 5 area is a deciduous/coniferous mix including *Tsuga canadensis*, *Acer spp*., and others, with a diverse understory (NEEA, 1998).

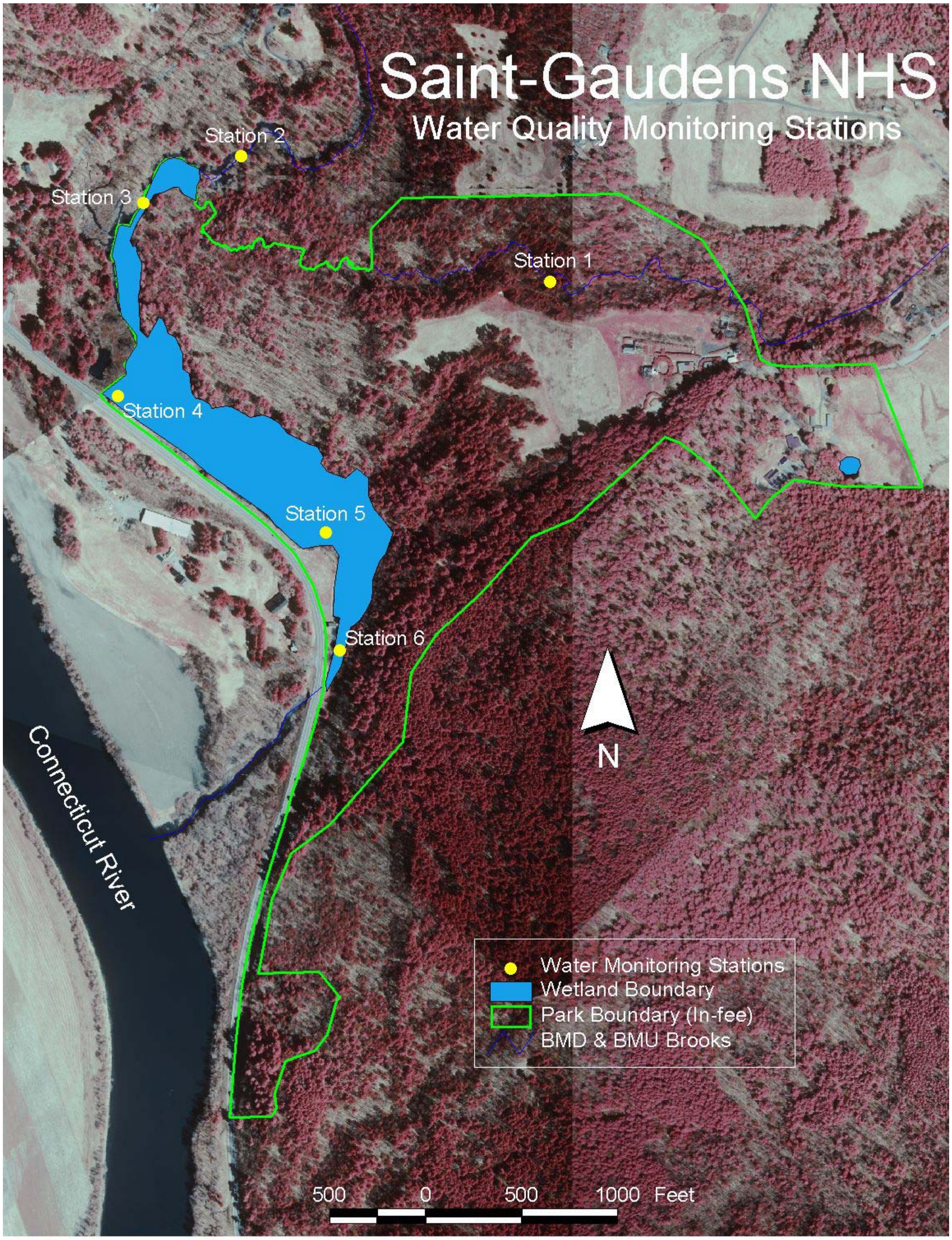


Figure 4. Water quality monitoring stations for SAGA. (Walasewicz)

The principle wetland functional values identified, based on the U.S. Army Corps of Engineers Highway Methodology Workbook, are wildlife habitat, plant diversity, recreation, scientific education, heritage, and aesthetic properties (NEEA, 1998). Additional wetland benefits may include water quality enhancement and flood mitigation (Mitsch and Gosselink, 1986b).

Floodplains and Riparian Zones

The Federal Emergency Management Agency (FEMA) has produced national assessments of flood prone areas. Map information is available on-line at http://store.msc.fema.gov/ or by contacting the Map Assistance Center at 877.336.2627. The FEMA community panel number used to access flood information in the SAGA area is 3301550005B. The 100 – 500 year floodplain has been defined for the Connecticut River, BMD and BMU Brooks for the SAGA area of interest (Figures 5a and 5b). Park projects within the 100 year floodplain delineated areas should conform to guidance described in EO 11988.

Riparian zones are complex biophysical habitats that encompass a stream channel between low and high watermarks (see Naiman, *et al*., 1993). These zones are important for regulating aquatic-terrestrial linkages that may provide early indications of environmental change (Decamps, 1993; Ward, 1989). Physically, riparian zones control mass movements of materials and channel morphology, provide woody debris, which can dissipate energy and trap moving materials, and control nonpoint sources of pollution (Naiman and Decamps, 1997). Ecologically, riparian zones provide sources of nourishment via allochthonous inputs to rivers and herbivory, contribute woody debris for habitat, create a complex of shifting habitats with different spatio-temporal scales due to flooding and water table fluctuation, and exert strong controls on stream microclimate (Naiman and Decamps 1997). Eastern Hemlock (*Tsuga Canadensis* (L.)) in the SAGA riparian area is susceptible to attacks by the hemlock wooly adelgid (*Adelges tsugae* Annand), which could result in negative impacts to surface water quality and affect other attributes described above (Jenkins, *et al*., 1999; Walasewicz, 1995).

Aquatic Biology

Pond, wetland, and riparian biological inventories have been produced and evaluated for SAGA (Appendix A) (Behler, *et al*., in prep.; Cook, 1986; Cronan, et al., 1981). The oligotrophic nature of the BMD pond and wetlands systems are evidenced by taxa lists indicating flora, zooplankton, and macroinvertebrate diversity along with low *chlorophyll a* concentrations (Cronan, et al., 1981). The aquatic characteristics provide generally cool conditions in the open pond and a warm water cattail, lily, and sedge community in the emergent zone (Cook, 1986).

The largest fish species diversity was recorded in the BMD Pond area due to the heterogeneous nature of the emergents, and the mix of still and flowing waters (Cook, 1986; Cronan, et al., 1981). A 2001 survey of herpetofauna identified 6 salamander, 7 anuran, 3 turtle, and 2 snake species in the SAGA (Behler, *et al*., in prep.). No threatened

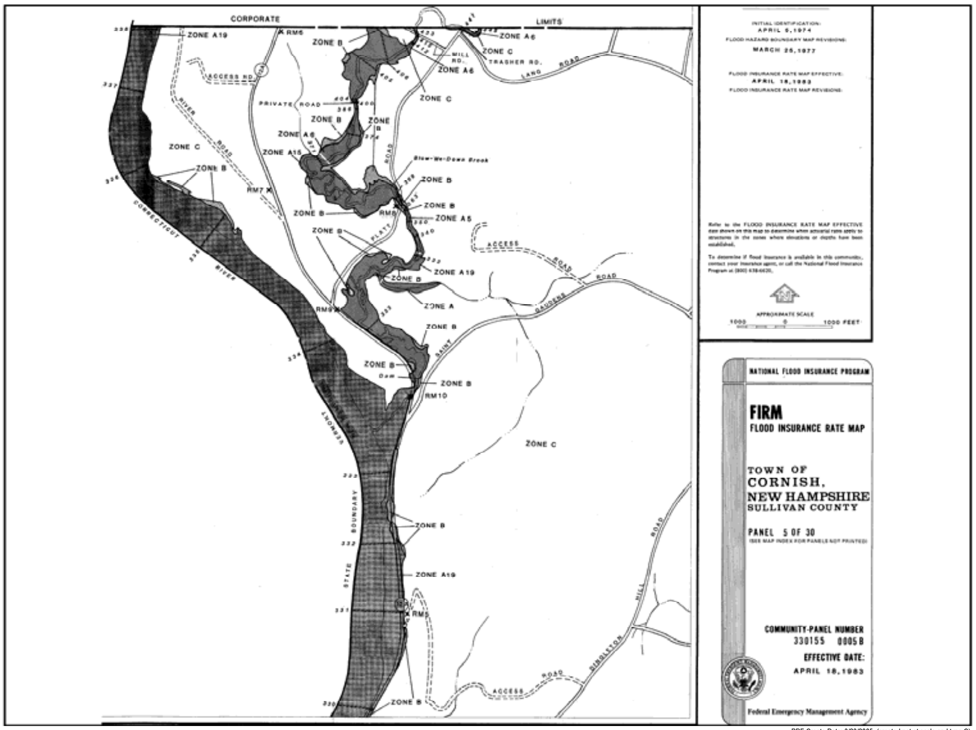
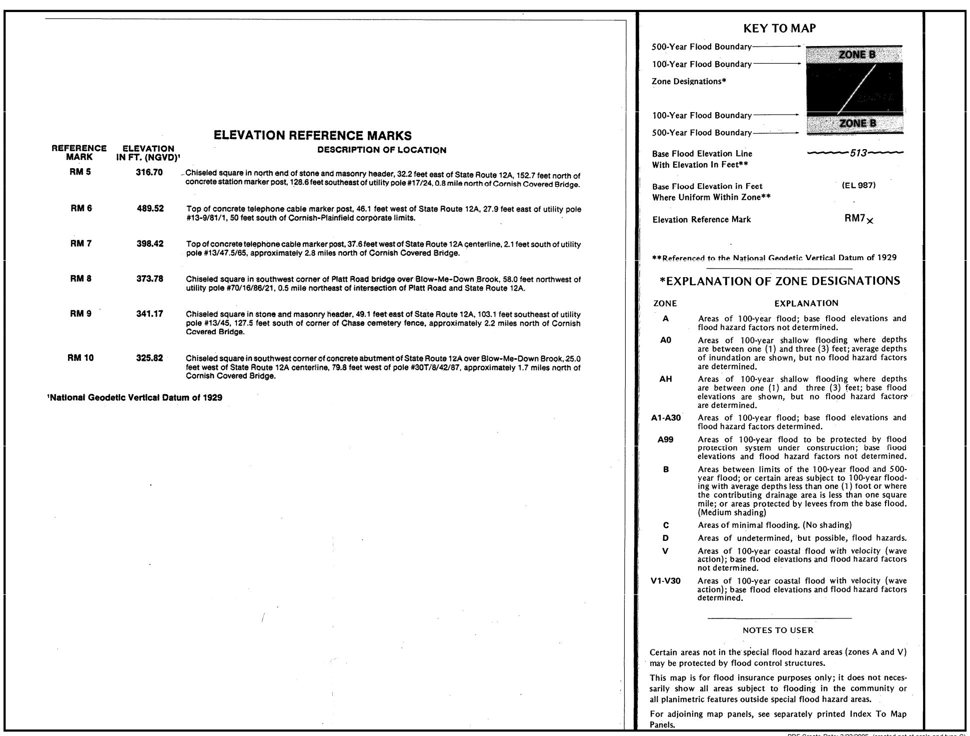


Figure 5a. FEMA floodplain map for SAGA vicinity.



ELEVATION REFERENCE MARKS

REFERENCE MARK	ELEVATION IN FT. (NGVD)[1]	DESCRIPTION OF LOCATION
RM 5	316.70	Chiseled square in north end of stone and masonry header, 32.2 feet east of State Route 12A, 152.7 feet north of concrete station marker post, 128.6 feet southeast of utility pole #17/24, 0.8 mile north of Cornish Covered Bridge.
RM 6	489.52	Top of concrete telephone cable marker post, 46.1 feet west of State Route 12A, 27.9 feet east of utility pole #13-9/81/1, 50 feet south of Cornish-Plainfield corporate limits.
RM 7	398.42	Top of concrete telephone cable marker post, 37.6 feet west of State Route 12A centerline, 2.1 feet south of utility pole #13/47.5/65, approximately 2.8 miles north of Cornish Covered Bridge.
RM 8	373.78	Chiseled square in southwest corner of Platt Road bridge over Blow-Me-Down Brook, 58.0 feet northwest of utility pole #70/16/86/21, 0.5 mile northeast of intersection of Platt Road and State Route 12A.
RM 9	341.17	Chiseled square in stone and masonry header, 49.1 feet east of State Route 12A, 103.1 feet southeast of utility pole #13/45, 127.5 feet south of corner of Chase cemetery fence, approximately 2.2 miles north of Cornish Covered Bridge.
RM 10	325.82	Chiseled square in southwest corner of concrete abutment of State Route 12A over Blow-Me-Down Brook, 25.0 feet west of State Route 12A centerline, 79.8 feet west of pole #30T/8/42/87, approximately 1.7 miles north of Cornish Covered Bridge.

[1]National Geodetic Vertical Datum of 1929

KEY TO MAP

500-Year Flood Boundary
100-Year Flood Boundary
Zone Designations*
100-Year Flood Boundary
500-Year Flood Boundary
ZONE B
ZONE B

Base Flood Elevation Line With Elevation In Feet** — 513

Base Flood Elevation in Feet Where Uniform Within Zone** — (EL 987)

Elevation Reference Mark — RM7×

**Referenced to the National Geodetic Vertical Datum of 1929

*EXPLANATION OF ZONE DESIGNATIONS

ZONE	EXPLANATION
A	Areas of 100-year flood; base flood elevations and flood hazard factors not determined.
A0	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined.
AH	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined.
A1-A30	Areas of 100-year flood; base flood elevations and flood hazard factors determined.
A99	Areas of 100-year flood to be protected by flood protection system under construction; base flood elevations and flood hazard factors not determined.
B	Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading)
C	Areas of minimal flooding. (No shading)
D	Areas of undetermined, but possible, flood hazards.
V	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined.
V1-V30	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined.

NOTES TO USER

Certain areas not in the special flood hazard areas (zones A and V) may be protected by flood control structures.

This map is for flood insurance purposes only; it does not necessarily show all areas subject to flooding in the community or all planimetric features outside special flood hazard areas.

For adjoining map panels, see separately printed Index To Map Panels.

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Figure 5b. Reference key for FEMA map above (figure 5a).

or endangered species have been noted; however, the wood turtle (*Clemmys insculpta*) - a New Hampshire species of special concern, Jefferson salamander (*Ambystoma jeffersonianum*) and pickerel frog (*Rana palustris*) - both uncommon, have been observed at SAGA (Behler, *et al*., in prep.; Cook, 1986). Avian sightings in the SAGA open water and emergent habitat have included the uncommon hooded merganser (*Lophodytes cucullatus*), traill's flycatcher (*Empidonax traillii*), green heron (*Butorides virescens*), and the Louisiana waterthrush (*Seiurus motacilla*) (Cronan, *et al*., 1981).

Twelve exotic and invasive plant species have been observed within SAGA wetland areas (Table 1). Purple loosestrife (*Lythrum salicaria*), yellow iris (*Iris pseudocorus*), Morrow's honeysuckle (*Lonicera morrowii*), and black swallow-wort (*Vincetoxicum nigrum*) have been treated to varying degrees. In 2001, loosestrife beetles (*Galerucella spp*.) were released to control *L. salicaria* and treatment efficacy is monitored annually through stem density measurements along two 130 ft (40 m) transects. Approximately 3,200 *I. pseudocorus* plants and rhizomes were removed by hand in 2003 (Walasewicz, pers comm.).

Purple loosestrife (*Lythrum salicaria*)
yellow iris (*Iris pseudocorus*)
Morrow's honeysuckle (*Lonicera morrowii*)
black swallow-wort (*Vincetoxicum nigrum*)
Norway Maple (*Acer platanoides*)
Japanese barberry (*Berberis thunbergii*)
Oriental bittersweet (*Celastrus orbinculatus*) glossy
buckthorn (*Frangula alnus*)
common buckthorn (*Rhamnus cathartica*)
black locust (*Robinia pseudo-acacia*)
multiflora rose (*Rosa multiflora*)
Japanese tree Lilac (*Syringa reticulate*)

Table 1. Invasive and exotic plant species known to exist in SAGA wetlands.

Soils

Cronan, *et al*. (1981), provide a comprehensive description of soils within SAGA. Briefly, soil deposits throughout the SAGA are classified as relatively young Entisols or Inceptisols. The epipedons are Ochric due to minimal organic accumulation and base cation availability. Soil types are Lithic Dystrochrepts, Typic Dystrochrepts, Typic Udipsamments, Aeric Haplaquents,
Typic Haplaquents, or Typic Udifluvent, depending on grain size and drainage. Due to poorly developed profiles along the Connecticut River floodplain, the SAGA soils may include Hydric Entisols, which lack typical morphological properties (Veneman and Tiner, 1990). The surficial geology includes lacustrine sediments, aeolian deposits, and

glacial outwash with a resulting soil structure range from well-drained loams to poorly-drained silts (Cronan, *et al*., 1981).

Air Quality

Air quality in the form of O_3, toxic volatile organic compounds, fine particulates ($PM_{2.5}$), wind direction and wind speed are currently measured by the New Hampshire Air Resources Division at a location south of SAGA in Claremont, NH. Previously, SO_2 and fine particulates (PM_{10}) were also measured at this site (NPS, 1996). Daily air quality forecasts for New Hampshire are available on the World Wide Web at http://www.airquality.nh.gov/air_quality_forecast.asp or by phone at 800.935.7664.

Atmospheric deposition and related effects to watershed components has been monitored since 1955 at the Hubbard Brook Experimental Forest (HBEF) near West Thornton, NH (43° 56' N, 71° 45' W). Wet and dry deposition parameters measured on a continual basis at HBEF include Ca, Mg, K, Na, NH_4, H, SO_4, NO_3, Cl, PO_4, and total precipitation (Likens and Bormann, 1995). Precipitation in the SAGA region, measured at HBEF, has a pH of 4.1, which is primarily affected by sulfuric and nitric acid inputs associated with human activities (Schlesinger, 1997; Likens and Bormann, 1995). Although atmospheric inputs of sulfur, and to some extent nitrogen, have declined in this area recently (Figure 6), cation concentrations have also decreased, resulting in little affect on rainfall acidity (Schlesinger, 1997).

Water Use Infrastructure

Water supply for the SAGA facilities is provided by a central well located north of the maintenance facility and museum collections storage area (well W2, Plate 1). The well is at an elevation of 570 ft (174 m) above sea level, 200 ft (61 m) deep, water head is at 11 ft (3.4 m), and yield is 19 gallons per minute (Moore, *et al*., 1994). Following chlorination, water is stored in three (3) 15,000 gallon fiberglass tanks with treatment and pumping service provided by a system installed in 2003. The water supply is tested monthly for total coliform and *Escherichia coli*, and annually for nitrite and nitrate. Additional water is available from the Big Johnson Spring, also referred to as Elm Spring, which runs through a supply line terminating on the east side of the visitor's center. One-third of the water yielded by this spring is reportedly deeded to SAGA (Healy, pers. comm.). The Park also has deed water rights to Oak Spring through a supply line at the southeast boundary.

Septic systems for the main complex were installed in 2002. Septic for the Aspet House and Little Studio was installed in the late 1800's. The older system receives minimal use, but remains active for seasonal staff and concerts. Another Park septic structure of similar age, which was constructed of brick in the form of a beehive, was recently removed. The current visitor parking area has a Clivus Multrum composting toilet. Septic maintenance generally occurs on a five-year cycle (Healy, pers. comm.).

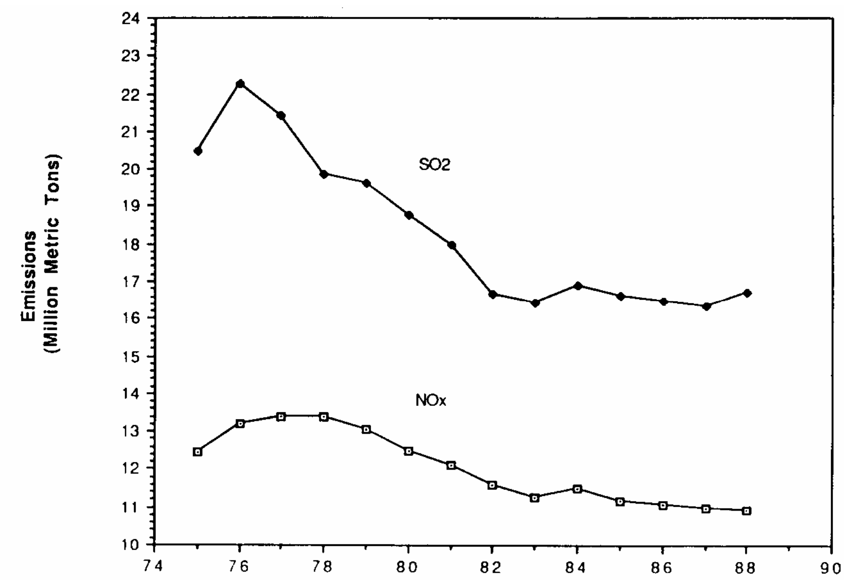

Figure 6. Decline in eastern United States nitrogen and sulfur emissions from 1975 through 1988 (from Likens and Bormann, 1995).

WATER RESOURCE ISSUES

Pond Maintenance

Three ponds formed by impoundments (Blow-Me-Down, the historic swimming hole, and Saint-Gaudens Farm) are located within SAGA. The stream-fed ponds are progressively experiencing shoaling as entrained sediment collects behind their respective dams (Faris, 2000). Ponds associated with stream impoundments are subject to sedimentation, which reduces storage capacity, forces autogenic successional changes in habitat type, and necessitates a maintenance program to insure desired functional values (Mitsch and Gosselink, 1986a; Dunne and Leopold, 1978). If current interpretation, recreation, and habitat conditions are to be retained, an ongoing sediment monitoring and removal program should be established.

Blow-Me-Down Pond is located adjacent to New Hampshire Route 12A, northwest of Saint-Gaudens Road. A dam has reportedly existed at the BMD Mill location since 1809 and the grist mill was constructed within the 100 year floodplain of BMD Brook in 1891 (Faris, 2000; NPS, 1996). The present dam (National Inventory of Dams #NH 00566; NPS #151) was constructed in 1935, reportedly reconstructed in 1940 after being washed out by a hurricane in 1938, rehabilitated in 1984, and is currently classified as a low hazard potential structure in a reasonably good state of repair. Sediment depths ranging from 2 to 9.2 ft (0.6 to 2.8 m) were measured at 50 ft (15.2 m) intervals to a point 200 ft (61 m) upstream of the dam in 1999. Sediment depths were measured with a silt probe pushed through the bottom strata to the point of refusal. The sediment measurements were used to estimate a deposition volume of 3900 yd^3 (2980 m^3) at that time (Faris, 2000). Average pond sediment depths of 3.6 ft (1.1 m) to a maximum of 7 ft (2.1 m) were measured along a different set of transects approximately two decades previously (Cronan, et al., 1981). Cook (1986) estimated a change from 40.5 ac (16.2 ha) to 15.25 ac (6.1 ha) open pond area over a 50 year period. Although sediment build-up is an issue, much of the loss of BMD Pond open surface water occurred in the 1950's during reconfiguration of NH Route 12A (Walasewicz, pers. comm.).

Due to creation of the dam along BMD Brook, the section immediately upstream from Route 12A transitioned from an alluvial meandering stream draining an incised hillslope to an open water pond. Historically, the pond was used by the Saint-Gaudens for ice skating during the winter months as well as a source of ice for the ice room located at the historic stables (Cronan, et al., 1981). Current recreation practices in the pond/marsh area include fishing, bird watching, and wetlands interpretation. The open pond system is shrinking in area as the adjacent marsh encroaches due to dam related siltation.

Ecosystem, interpretive, and recreation maintenance for BMD Pond will require a routine, 5-10 year, autumnal pond dredging maintenance program (Cook, 1986; Cronan, et al., 1981). The maintenance program should include sediment accretion and habitat area monitoring to establish rates of sedimentation and associated habitat change to support dredge operation frequencies (NPS, 1997). The most recent dredging operation at BMD Pond involved a prolonged water level drop to facilitate dam maintenance and the removal of 6880 m^3 of silt in 1984. This action resulted in painted turtle mortality and the elimination of pickerel from the pond due to procedural deficiencies (Cook, 1986). According to Cook (1986), dredging operations should occur in late summer or autumn to minimize damage to aquatic communities. Operations in late fall would reduce project impacts by providing a time of dried or frozen soils, lower flows, and decreased wildlife activity.

Blow-Me-Up Dam (NPS dam inventory #784) was constructed across Blow-Me-Up Brook in the late 1800's to create a recreational pool. The pool was observed filled to the top of the dam with gravel and sediment during an assessment in 1999. While dam failure was classified as a low hazard potential, stabilization efforts were recommended for the structure if SAGA determined sediment removal was desirable (Faris, 2000). The BMU swimming pond is currently a wide, shallow point in the brook, which fills with sediment following major streamflow events. Boards are removed from the dam in the fall to allow water to flow through and reduce sedimentation and the pool has been periodically maintained by volunteers.

Sediment accretion rates in the historic swimming hole should be measured annually. A desired pool size and depth should be established for interpretive purposes and material should be removed based on the rate of accretion. Spoil placement should be established with the State of New Hampshire Department of Environmental Services authorities.

The Saint-Gaudens Farm Pond Dam, constructed by a former property owner, was listed as in unsatisfactory condition when inspected in 1999 following NPS acquisition. The dam was classified as a low hazard potential structure in need of repair. Maximum dam capacity was estimated at 3 ac ft (3700 m^3) with a 0.33 ac (0.13 ha) surface area. The reservoir level is maintained by a steady underground spring denoted by S1 on Plate 1 (Faris, 2000). The uncommon Pickerel Frog (*Rana palustris*) was recently noted at this site (Behler, *et al*., in prep.). The Park is considering the installation of a dry fire hydrant at this pond for fire protection.

Since the Farm Pond Dam is primarily spring fed, shoaling is not a concern. Sediment input to the pond would be associated with overland flow, which is minimal due to the surrounding vegetative cover, and aeolian material. Farm Pond is not used for interpretation, nor does it serve a primary water source function. Due to the potential for deterioration, Faris (2000) recommended removal of the dam in lieu of alternative park benefits from the water supply. Given the low hazard potential of the dam, and habitat benefits provided by the pond, no action is currently deemed necessary.

Sedimentation rates can be inexpensively estimated using periodic depth-to-sediment measurements (NPS, 1997). Measurements from water surface to pond bottoms should be made along established transects at periodic intervals. Transects used for previous studies at BMD Pond (Faris, 2000; Cronan, et al., 1981) should be incorporated into a new monitoring program for comparison. Depth measurements at BMD Pond could be made with a secchi disk, which would provide simultaneous turbidity and trophic status information (Novotny and Olem, 1994). A staff gage should be installed at both ponds monitored to allow for stage height adjustment of sediment measurements. Sediment rates will not be static as sediment load is dictated by land use and storm event intensities throughout the watershed. Change in habitat should be surveyed by reviewing cover types from photos taken at established locations (Cook, 1986).

Feasibility and enactment of dredging activities should be conducted by reputable contractors with expertise in local dredging activities and associated regulations. Sediment should be assessed for toxic contamination prior to removal and disposal. Dredging expertise is available from the U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS (EL-Inquiry@erdc.usace.army.mil). The NHDES issues general wetland impact permits (GP-52) for minor, non-controversial projects. Regulations are provided on the World Wide Web at www.des.nh.gov/wetlands or the NHDES wetlands group may be contacted directly in Concord, NH (phone: 603.271.2147). Projects impacting wetland areas larger than 3 ac (1.2 ha), e.g. BMD Pond, require permit authority from the U.S. Army Corps of Engineers, Concord, MA (phone: 800.343.4789). The BMD Pond dredging project would require an Environmental Assessment to comply with the National Environmental Policy Act and be subject to the Corps of Engineers Section 404 Clean Water Act permit process. Additional compliance with Section 106 of the National Historic Preservation Act and the Federal Endangered Species Act may be required as appropriate.

The National Park Service has established guidelines for wetlands protection under Director's Order #77-1. These guidelines may be reviewed on the World Wide Web at www.nps.gov/policy/DOrders/DO77-1-Reissue.htm. The NPS guidelines listed in DO #77-1 establish agency policies for compliance with Executive Order 11990 "Protection of Wetlands", Executive Order #11988 "Floodplain Management", and the "no net loss of wetlands" goal of 1989. Foremost, NPS policy calls for avoidance of adverse impacts on wetlands, followed by impact minimization, then compensation for wetland functional loss on a 1:1 minimum replacement ratio. Cook (1986) describes the loss of wildlife habitat and aesthetic resources associated with a BMD Pond 'no action' alternative for dredging, and lists resource impact minimization strategies.

Surface Water Quality

Water quality in New Hampshire river basins has been adversely affected by human activities (Robinson, *et al*., 2004; Zimmerman, *et al*., 1996). Degradation of water quality in small streams due to nonpoint pollution sources such as residential septic systems, storm runoff, and agricultural land use is a growing concern in the Connecticut River Basin (Zimmerman, *et al*., 1996). While recent efforts to improve the state of the Connecticut River and its tributaries have heralded the return of fishable and swimmable waters through controls on municipal sources, relative contributions of other geographic areas are not adequately understood (Zimmerman, *et al*., 1996; Yaro, *et al*., 1993). The headwaters of BMD and BMU Brooks are located adjacent to potentially degrading land uses including septic systems, agricultural production, and increasing development pressures. Through examination of small watersheds like that of BMD Brook at SAGA, ecosystem integrity and impact source area information can be gathered to support Park and basin management strategies.

Due to lack of consistency among methods, sample locations, and stream discharge information the need to establish a long term water quality monitoring program for SAGA was identified (Roman, 1992). Justification and standard operating procedures for a water monitoring program at SAGA were presented by Zubricki (1995). Monthly monitoring of macroinvertebrates, nitrogen as ammonium and nitrate, phosphorous, fecal coliform bacteria, conductivity, pH, water temperature, turbidity, dissolved oxygen, and stream discharge was initiated for multiple locations in 1997 (Walasewicz, 2003; Zubricki, 1995). Six sample locations were established to allow interpretation of water quality change through the park area and identification of distinct impact locations (figure 4) (Zubricki, 1995).

Data analyses are reported on an annual basis by the SAGA natural resource staff. Monitoring reports do not indicate large variation by sample site for most parameters; however, temporal differences have been observed (Walasewicz, 2003; Walasewicz, 2001; Walasewicz, 1997). The Walasewicz (2003) SAGA report was designed to include a statistical analysis of all parameters measured across the range of years examined. The variability of data results does not indicate degradation of water quality within park boundaries during that period.

Adherence to standard operating procedures described in the sampling plan is imperative in data collection and evaluation. Deviation from standard water collection, sample handling, storage, and shipping protocols may negate validity of samples. The current sample plan indicates laboratory samples will be placed on ice in a cooler and transported to an analytical laboratory within six hours of collection (Zubricki, 1995). Since the analytical laboratory is located at the NPS Cape Cod site (CACO), this timeframe requires adjustment. Quality control protocols utilized by the CACO lab for surface water samples call for processing as soon as possible after collection with a maximum holding time of 24 hours for NH_4 and 48 hours for NO_3 and PO_4 (Liao, 2003; Diamond, 2003; Knepel and Bogren, 2001). Regulatory standards for sample handling list 48 hours maximum recommended for PO_4 analysis and 28 days maximum storage for preserved N species (APHA, 1998).

The current monitoring scheme should be reevaluated to determine the necessity of six sample locations along a stream reach spanning just over a mile (2 km). The sampling scheme established by Zubricki (1995) was designed to determine how surface water quality changes as water travels through the park area. The primary goal listed for the park is to quantitatively assess the overall condition of the park's water resources (Walasewicz, 2003). The current scheme exceeds the needs of baseline monitoring for the site. However, if the desire is to assess distinct characteristics of discrete stream segments, it may be possible to utilize the information collected to establish cause and effect relationships associated with differences between sample locations.

Blow-Me-Down Brook watershed health could be monitored by sampling at a current downstream location, e.g. Site 5 or 6, with the addition of a continuous stage recorder. A stage-discharge relationship could be established to provide ongoing flow estimations for the site (Harrelson, et al., 1994; Herschy, 1985). In addition to providing nutrient flux data, continuous discharge monitoring would supplement pond sedimentation rate estimations described below. If partitioning of the BMU watershed is desired, the sample location along BMU Brook could be retained and equipped with a stage recorder also. The current suite of monitoring parameters is appropriate for general water quality assessment, but would benefit from the inclusion of acid neutralizing capacity (ANC).

Water quality monitoring should be continued at the SAGA for the benefit of NPS lands and to provide valuable information regarding small watershed land use effects on large rivers. Monitoring plans should be routinely evaluated to insure methods and desired outcomes continue to be appropriate for NPS goals. Interpretation and use of water quality data should include a review by NPS regional or water resource division staff and final reports should be made available to interested parties. Reports should include water resource standards at federal and local levels to indicate compliance [defined in State of NH Surface Water Quality Regulations Chapter 1700 Part Env-Ws 1703 (www.gencourt.state.nh.us/rsa/html/L/485-A/485-A-8.htm) and Title L Water Management and Protection Chapter 485-A Water Pollution and Waste Disposal (www.des.state.nh.us/wmb/env-ws1700.pdf)]. Data should be entered into the STORET database on an annual basis, which can be accomplished through the NPS WRD or the New Hampshire Department of Environmental Services (NHDES) Water Quality Assessment Program's Environmental Monitoring Database. The NHDES water quality group can be reached by phone at 603.271.8864 or on the World Wide Web at www.des.state.nh.us/wmb/swqa.

RECOMMENDATIONS

- Saint-Gaudens National Historic Site is located in a humid continental climate. Water quantity is generally not a limiting factor, but water quality in this region has been degraded by anthropogenic influences. The SAGA surface water quality monitoring program should be reassessed to include continuous flow monitoring, reduction from 6 to a maximum of 2 sample locations, review of shipping and handling protocols, desired sampling parameters, appropriate statistical comparisons, and dissemination of the annual report for review. The Northeast Temperate Network is developing an aquatic monitoring program, which will provide guidance on minimum sampling efforts. Additional sampling may be appropriate to build on current datasets. Saint-Gaudens National Historic Site's successful efforts to provide educational outreach related to water quality monitoring should be continued. Water monitoring data should be entered into the STORET database, and the NHDES requests that data be provided for entry into their Environmental Monitoring Database for state tracking and reporting purposes.

- Two ponds formed by impoundments along the stream network of SAGA are experiencing siltation associated with the highly erodible, glacially deposited soils of this region. A sedimentation rate monitoring program should be established for the impounded waters to support sediment removal needs to protect the desired interpretive and ecosystem functions of SAGA ponds. A dredging plan should be established based on sedimentation rates and preservation of natural and cultural resource values. The plan should include desired conditions, dredging frequency based on measured sedimentation rates, appropriate methods based on current technology, NEPA analysis, state and national wetlands manipulation regulatory controls, a Statement of Findings for the NPS Water Resources Division, and a pre/post construction monitoring plan. The Eleanor Roosevelt National Historic Site is undergoing a similar dredging process, which could be reviewed for planning purposes.

- Saint-Gaudens National Historic Site water and wetland habitats support diverse and healthy floral and faunal populations, including uncommon species for the state of New Hampshire. The Northeast Temperate Network (NETN) will provide a wetland assessment in the near future; however, protocols for this inventory have not yet been developed. Information provided in the NEEA (1998) and Schweisberg (1992) wetlands assessments should be combined into a single reference map for planning purposes. A GIS-based wetland delineation using the Cowardin, *et al*. (1979) methods prescribed in *DO #77-1, section 5.1* is advised in order to fully describe the current state of the park. This information will then be available to support and document pond dredging and other management impacts to wetland areas.

- Air quality in the SAGA region has been negatively impacted. Atmospheric deposition contaminants have resulted in watershed degradation regionally and globally. Air quality reports from the nearby Claremont, NH and the Hubbard Brook Experiment Site should be reviewed on an annual basis. Comparison of air quality trends with water quality results may provide causal relationship information.

- Population growth in the Cornish community is currently static and land cover is primarily forest with some agriculture and rural homes within the watershed. The NPS should work closely with local and state land use planning authorities and individual landowners to encourage development management and preservation of wetland and forest communities within the entire BMD Brook watershed. Improperly managed land use change could result in increased sediment load, changes in hydrologic flow paths, and nutrient or pesticide leaching to surface or ground water.

- The SAGA water supply system appears adequate for current usage needs and most of the wastewater systems were recently upgraded. The agreement to use water from the Big Johnson (Elm) Spring should be established in writing to avoid potential confusion in the event the park requires use of this resource. If non-chlorinated water is desired for irrigation, use of untreated spring water could be considered to fulfill this need. The septic system providing service to the Little Studio and the Aspet House was constructed in the late 1800's. Although this system appears to be functioning properly for uses to date, its antiquity suggests an upgrade is appropriate. The composting toilet located adjacent to the parking area is reportedly not functioning properly and replacement with a vault system may be desirable.

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Appendix 1. List of aquatic species documented within SAGA. (from Behler, *et al*., in prep.; Cook, 1986)

Fish

Brook Trout (*Salvelinus fontinalis*)
Chain Pickerel (*Esox niger*)
Creek Chub (*Semotilus atromaculatus*)
Fallfish (*Semotilus corporalis*)
Bluntnose Minnow (*Pimephales notatus*)
Common Shiner (*Notropis cornutus*)
Golden Shiner (*Notemigonus crysoleucas*)
Longnose Dace (*Rhinichthys catactae*)
Blacknose Dace (*Rhinichthys atratulus*)
Redbelly Dace (*Phoxinus eos*)
Longnose Sucker (*Catostomus catostomus*)
Brown Bullhead (*Ictalurus neblosus*)
Rock Bass (*Ambloplites rupestris*)
Bluegill (*Lepomis macrochirus*)
Pumpkinseed (*Lepmis gibbosus*)
Redbreast Sunfish (*Lepomis auritus*)
Yellow Perch (*Perca flavescens*)
Tessellated Darter (*Etheostoma olmstedi*)

Amphibians

Yellow-Spotted Salamander (*Ambystoma maculatum*)
Jefferson Salamander (*Ambystoma jeffersonianum*)
Eastern Red-Spotted Newt (*Notophthalmus viridescens*)
Red-Backed Salamander (*Plethodon cinereus*)
Northern Two-Lined Salamander (*Eurycea bislineata*)
Northern Dusky Salamander (*Desmognathus fuscus*)
Eastern American Toad (*Bufo americanus*)
Northern Spring Peeper (*Pseudacris crucifer*)
Gray Treefrog (*Hyla versicolor*)
Wood Frog (*Rana sylvatica*)
Pickerel Frog (*Rana palustris*)
Green Frog (*Rana clamitans*)
American Bullfrog (*Rana catesbiena*)

Reptiles

Snapping Turtle (*Chelydra serpentina*)
Wood Turtle (*Clemmys insculpta*)
Painted Turtle (*Chrysemys picta*)
Eastern Garter Snake (*Thamnophis sirtalis*)
Eastern Milk Snake (*Lampropeltis triangulum*)
Ring-Necked Snake (*Diadophus punctuatus*)

As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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